

CLAIMS

1. A force feedback interface device implementing a selective disturbance filter for reporting filtered data to a host computer system, said host computer system implementing and displaying a graphical environment, the interface device comprising:

a user manipulatable object physically contacted by a user and movable in physical space in a degree of freedom with respect to a ground;

a sensor operative to detect said movement of said user manipulatable object in physical space in said degree of freedom with respect to said ground and output sensor signals representative of said movement;

an actuator coupled to said user manipulatable object and operative to apply an output force in said degree of freedom of said user object; and

a microprocessor, separate from said host computer, coupled to said sensor and to said actuator, said microprocessor operative to receive host commands from said host computer and output force signals to said actuator for controlling said output force on said user object, and operative to receive said sensor signals from said sensors and report locative data to said host computer derived from said sensor signals and indicative of said movement of said user manipulatable object, said host computer updating a position of a user-controlled graphical object based on at least a portion of said locative data, wherein said microprocessor implements a selective disturbance filter for modifying said locative data reported to said host computer when said output force would cause a disturbance to said user-controlled graphical object.

2. A force feedback interface device as recited in claim 1 wherein said modification of said locative data is performed by said microprocessor when said output force on said user manipulatable object affects said position of said user object such that said host computer would display said user-controlled graphical object in an undesired location on a display screen coupled to said host computer.

3. A force feedback interface device as recited in claim 2 wherein said selective disturbance filter is associated with at least one force sensation controlled by said microprocessor, such that said selective disturbance filter modifies said reported data only when said associated force sensation is output by said actuator.

4. A force feedback interface device as recited in claim 3 wherein a plurality of different types of force sensations can be commanded by said microprocessor to be output by said actuator.

5. A force feedback interface device as recited in claim 4 wherein said at least one of said different types of force sensations can be commanded by said host computer by providing a host command to said microprocessor.

6. A force feedback interface device as recited in claim 5 wherein said selective disturbance filter is activated by said host computer by providing a host command.

7. A force feedback interface device as recited in claim 5 wherein said modifying of said locative data is performed if said output force sensation is associated with said selective disturbance filter that has previously been commanded to be active by said host computer.

8. A force feedback interface device as recited in claim 4 wherein at least one of a plurality of available selective disturbance filters may be used to modify said locative data.

9. A force feedback interface device as recited in claim 8 wherein at least one of said plurality of selective disturbance filters may be commanded to be active by said host computer.

10. A force feedback interface device as recited in claim 1 wherein said modification of said locative data includes sampling said locative data over time according to a sampling rate, and reporting only said sampled locative data to said host computer.

11. A force feedback interface device as recited in claim 1 wherein said modification of said locative data includes time-averaging said locative data and reporting said averaged data to said host computer.

12. A force feedback interface device as recited in claim 1 wherein said modification of said locative data includes sampling and holding a data value derived from said sensor signals before said force sensation is output, wherein said held data value is reported to said host computer during said force sensation.

13. A force feedback interface device as recited in claim 1 wherein said modification of said locative data includes using a spatial filter to sample and hold a data value derived from said sensor signals, said data value representing a last position of said user object before said user object is moved out of a predetermined region in said graphical environment.

14. A force feedback interface device as recited in claim 1 wherein said different types of force sensations include a periodic force, an impulse force, and a snap force.

15. A force feedback interface device as recited in claim 14 wherein said periodic force is a vibration that causes a disturbance of a vibrating cursor when said reported locative data is not modified.

16. A force feedback interface device as recited in claim 14 wherein said impulse force is a jolt that causes a disturbance of a cursor that is suddenly moved in a direction corresponding to said jolt when said reported locative data is not modified.

17. A force feedback interface device as recited in claim 14 wherein said snap force is an attraction force associated with a target that causes a visual disturbance of a cursor overshooting said target when said reported locative data is not modified.

18. A force feedback interface device as recited in claim 3 wherein user controlled graphical object is a cursor.

19. A force feedback interface device as recited in claim 18 wherein said graphical environment is a graphical user interface.

20. A force feedback interface device as recited in claim 3 wherein user controlled graphical object is a simulated entity in a simulated environment of a graphical video game.

21. A force feedback interface device as recited in claim 20 wherein said selective disturbance filter is applied to locative data derived from sensor signals input to said microprocessor during an outputting of forces simulating a recoil of a simulated gun controlled by said user in said graphical video game.

22. A method for selectively filtering visual disturbances associated with forces occurring in a force feedback system, the method comprising:

receiving a command at a force feedback interface device from a host computer to output a force sensation on a user manipulatable object of said force feedback interface device;

determining whether said force sensation is associated with a disturbance filter process stored in a computer readable medium;

determining whether said associated disturbance filter process is enabled;

filtering input data according to said associated disturbance filter process if said associated disturbance filter process is enabled, said input data being received from sensors

during said output of said force sensation and being representative of a position of said user object in a degree of freedom; and

reporting said filtered input data to said host computer, said host computer using at least part of said filtered data to update a position of a user controlled object in a displayed graphical environment.

23. A method as recited in claim 22 further comprising receiving a command from said host computer to enable said associated disturbance filter process.

24. A method as recited in claim 22 wherein said filtering includes time-sampling said input data according to a predetermined periodic interval and providing said sampled data as said filtered data.

25. A method as recited in claim 22 wherein said filtering includes time-averaging said input data according to a predetermined averaging window and providing said averaged data as said filtered data.

26. A method as recited in claim 22 wherein said filtering includes sampling and holding a value of said input data, said value being received before said force sensation is output, and reporting said held value as said filtered data.

27. A method as recited in claim 22 wherein said filtering includes storing and holding a data value representing a last position of said user object before said user object exited a predetermined region in said graphical environment, and reporting said last position value as said filtered data.

28. A method as recited in claim 22 wherein said force sensation is one of a plurality of different available force sensations that may be output by said force feedback interface device, wherein at least two of said force sensations are associated with different disturbance filter processes.

29. An apparatus for providing force feedback to a user in conjunction with the display and updating of a graphical environment by a host computer system coupled to the apparatus, the apparatus comprising:

a user manipulatable object physically contacted by a user and movable in physical space in a degree of freedom with respect to a ground;

sensor means operative to detect said movement of said user manipulatable object in physical space in said degree of freedom with respect to said ground and output sensor signals representative of said movement;

actuator means coupled to said user manipulatable object and operative to output a force in said degree of freedom of said user object;

means for outputting force signals to said actuator means to control said output force on said user object,

means for receiving said sensor signals from said sensors and reporting locative data to said host computer derived from said sensor signals and indicative of said movement of said user manipulatable object, said host computer updating a position of a user-controlled graphical object based on at least a portion of said locative data,

means for filtering said locative data reported to said host computer when said output force would cause a visual disturbance to said user-controlled graphical object.

30. A force feedback interface device as recited in claim 29 wherein said visual disturbance occurs when said output force on said user manipulatable object affects said position of said user object such that said host computer would display said visual disturbance in a location of said user-controlled graphical object on a display screen coupled to said host computer.

31. A force feedback interface device as recited in claim 30 wherein said means for filtering is associated with at least one force sensation controlled by said microprocessor, such that said means for filtering filters said locative data when said associated force sensation is output by said actuator.

32. A force feedback interface device as recited in claim 31 wherein said associated force sensation is a jolt coordinated with a simulated recoil of a simulated gun controlled by said user in said graphical environment.

33. A force feedback interface device as recited in claim 31 wherein a plurality of different types of force sensations can be commanded by said microprocessor to be output by said actuator.

34. A force feedback interface device as recited in claim 33 wherein said at least one of said different types of force sensations can be commanded by said host computer by providing a host command to said microprocessor, and wherein said selective disturbance filter can be enabled by said host computer by providing a host command.

5 35. A force feedback interface device as recited in claim 34 wherein said filtering of said locative data is performed if said output force sensation is associated with said selective disturbance filter that has previously been commanded to be active by said host computer.

10 36. A force feedback interface device as recited in claim 29 wherein said filtering of said locative data includes at least one of time sampling said locative data over time according to a sampling rate, time-averaging said locative data, sampling and holding a data value derived from said sensor signals before said force sensation is output, and sample and hold a data value derived from said sensor signals, said data value representing a last position of said user object before said user object is moved out of a predetermined region in said graphical environment.

15 37. A force feedback interface device as recited in claim 33 wherein said different types of force sensations include a periodic force, an impulse force, and a snap force.

38. A method for selectively decoupling an input channel from an output channel in a force feedback interface device by filtering input data, the method comprising:

20 outputting a force sensation in a degree of freedom of a user manipulatable object of said force feedback interface device, said force sensation being correlated with an event in a graphical environment implemented by a host computer coupled to said force feedback interface device, said event involving a user-controlled graphical object displayed in said graphical environment;

determining whether said force sensation is associated with at least one of a plurality of disturbance filters stored in a computer readable medium;

25 filtering input data according to at least one of said associated disturbance filter, said input data being received from sensors during said output of said force sensation and being representative of a position of said user object in said degree of freedom; and

using said filtered input data to update said user controlled object in said displayed graphical environment.

39. A method as recited in claim 38 further comprising determining whether said associated disturbance filter process is enabled, and performing said filtering only if said associated disturbance filter process is active.

5 40. A method as recited in claim 39 further comprising receiving a command from a host computer coupled to said force feedback interface device to activate said associated disturbance filter process.

41. A method as recited in claim 40 wherein said outputting of said force sensation is commanded by said host computer using a host command.

10 42. A method as recited in claim 38 wherein said force sensation is one of a plurality of different available force sensations that may be output by said force feedback interface device, wherein at least two of said force sensations are associated with different disturbance filter processes.

15 43. A computer readable medium including program instructions for performing steps of:

receiving sensor data from sensors on a force feedback interface device, said sensor data representing motion of a user manipulatable object in a degree of freedom;

20 filtering said sensor data if said sensor data has been influenced by a force sensation output by actuators of said force feedback interface device and if said force sensation has been previously specified to require said filtering;

reporting said filtered sensor data to a host computer, said host computer implementing a graphical environment and updating a user-controlled graphical object based on said filtered sensor data.

25 44. A computer readable medium as recited in claim 43 wherein said filtering is provided according to a selective filter process, wherein a plurality of selective filter processes are available, each of said selective filter processes being operative to filter input data influence by at least one of a plurality of different force sensations that can be output by said force feedback interface device.